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F16L 59/10, H02G 3/04

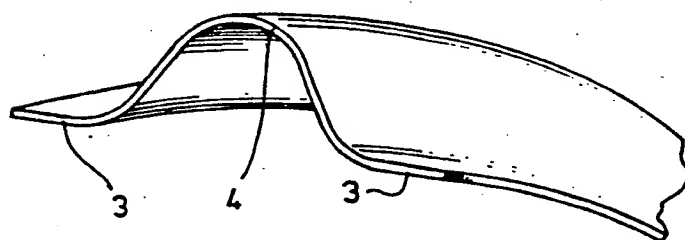
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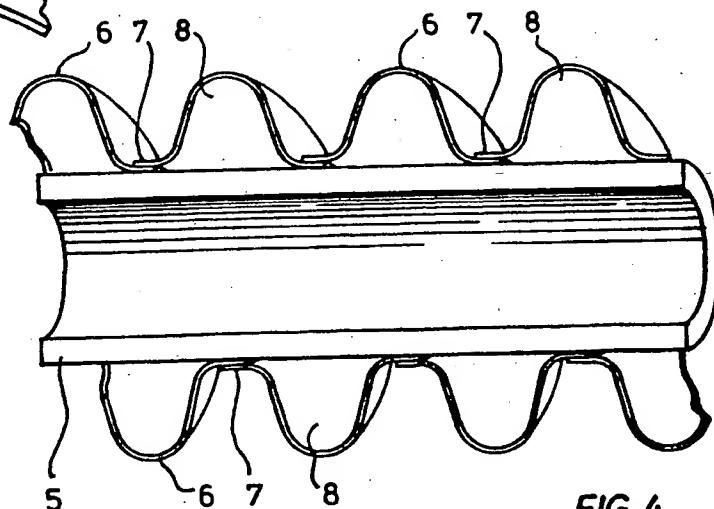
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INT CL<sup>5</sup> F16L 59/08 59/10

(54) **Heat reflective ducting**

(57) A tubular textile artefact 5 helically wrapped with an elongated strip of reflective foil eg aluminized polyester is characterised in that the foil strip is pre-treated so that the central region 6 of the strip has a greater length in the axial direction than either of its side edges 7 to thereby permit flexibility. The increase in length may be obtained by passing over a tool (Fig 7 not shown), by pleating or heat shrinking the edges (Fig 8 not shown) or by attaching the edges to stretched elastic strips with subsequent recovery of the strips (Fig 9 not shown). The tubular artefact may protect fuel pipes or electrical cables.



**FIG. 2**



**FIG. 4**

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

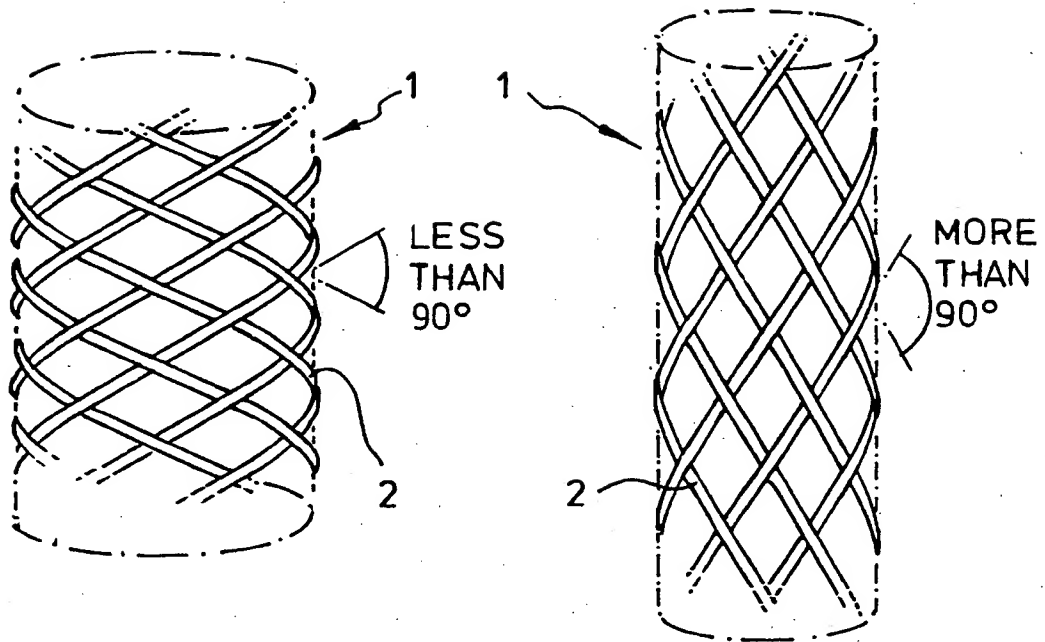


FIG. 1A

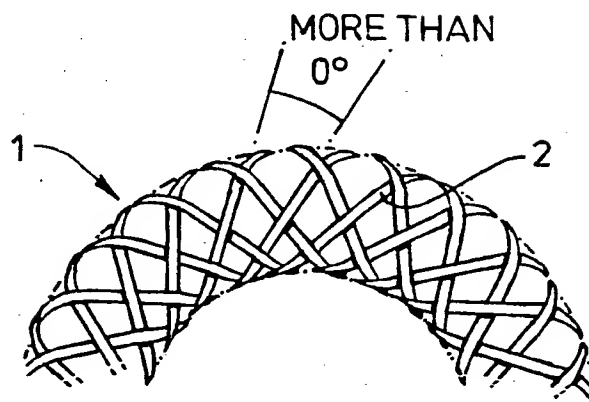


FIG. 1B

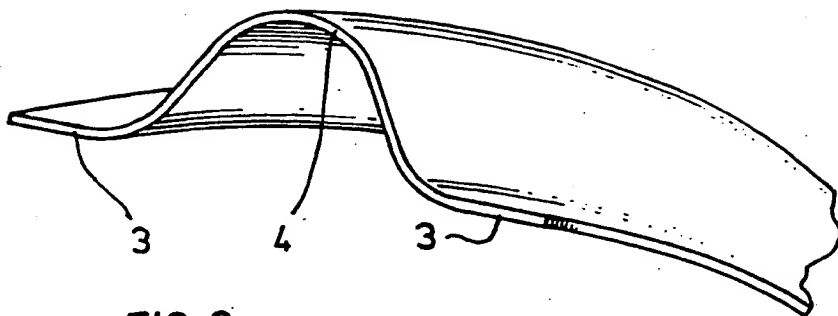


FIG. 2

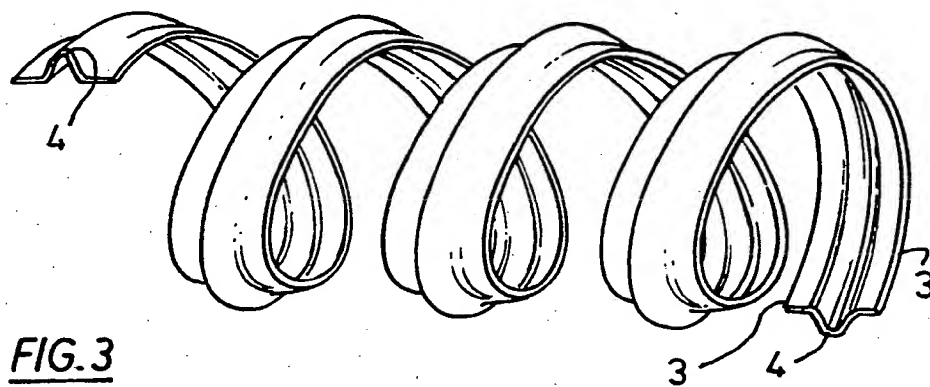


FIG. 3

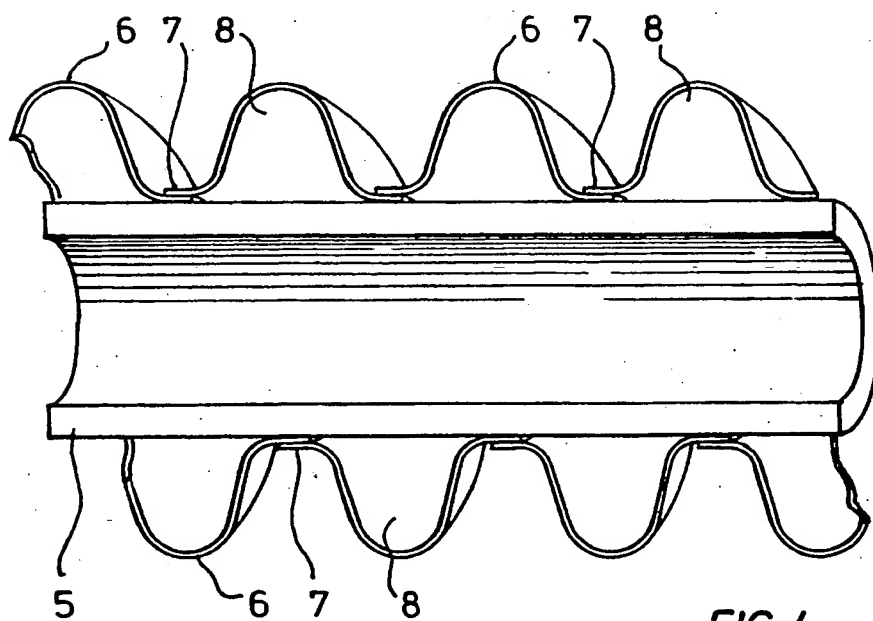
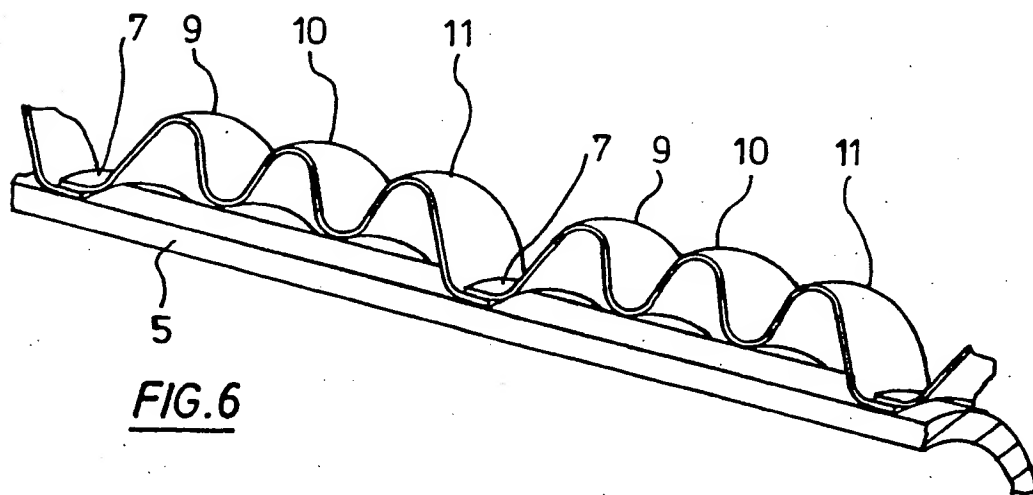
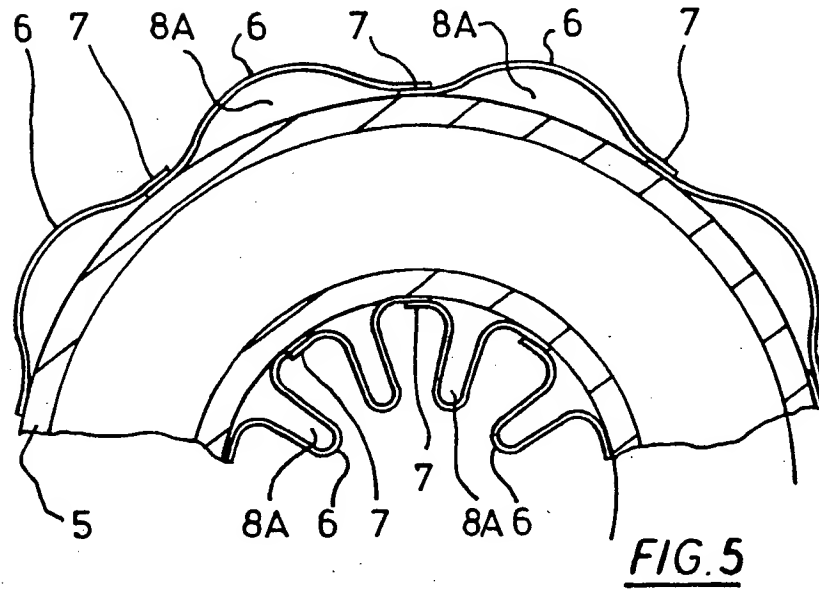


FIG. 4



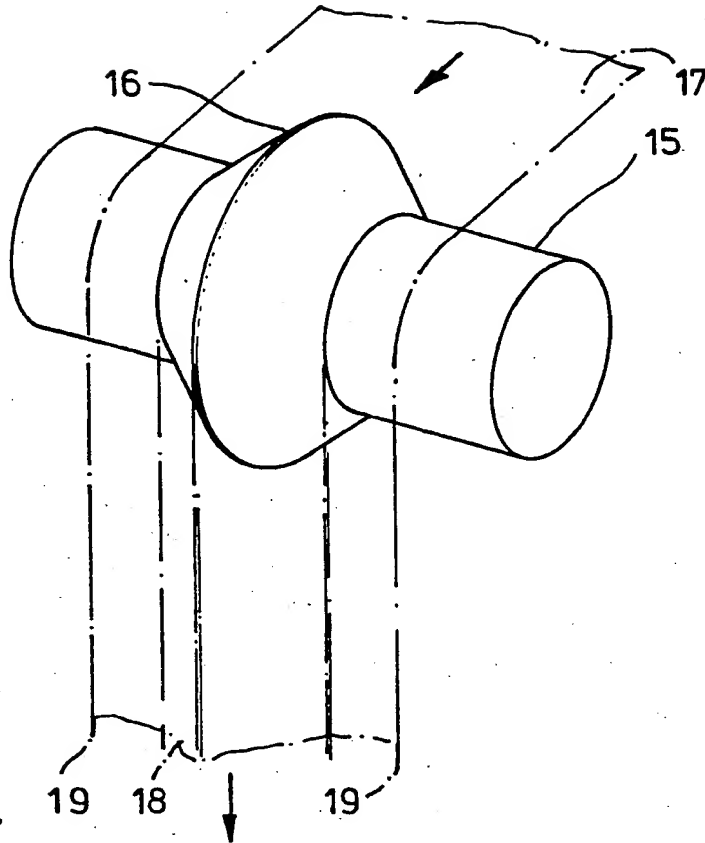


FIG. 7

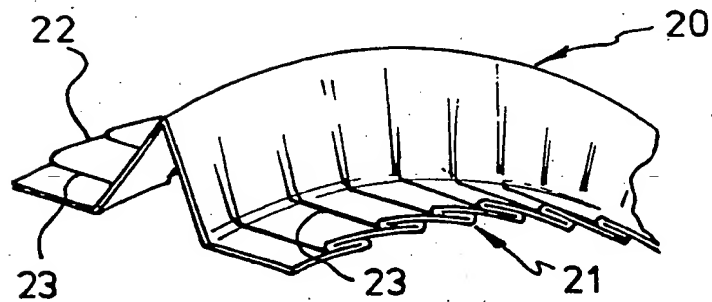


FIG. 8

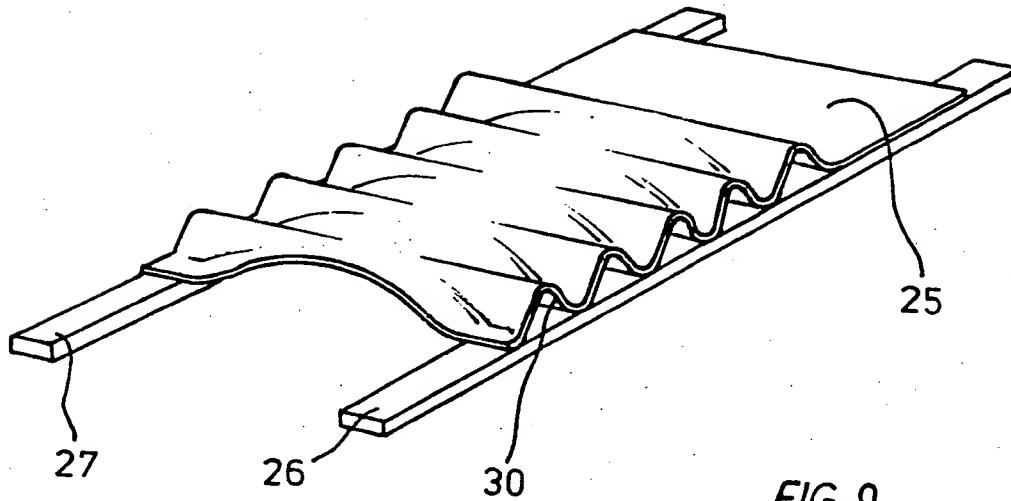


FIG. 9

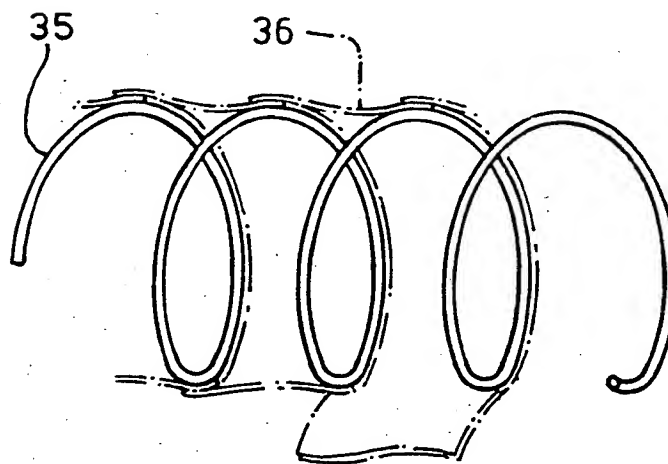


FIG. 10

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Improvement in and relating to tubular insulation products

This invention relates to flexible ducting of the kind commonly used to protect electrical cables, fuel pipes and the like from the effect of radiant heat. Typical applications for such products are found in the engine compartment of motor vehicles where cables and fuel pipes are exposed to radiant heat from the engine and/or exhaust system.

One well-known material that is commonly used for such applications is a flexible textile tube made by braiding or knitting a temperature resistant material such as glass fibres. A problem with conventional textile materials is their imperfect reflecting properties. Thus the reflectivity of glass fibre is relatively high but cannot really compare with that of a surface such as metallic

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aluminium. A further problem is the gaps between the individual threads of the braided or knitted structure. These allow passage of infra-red radiation, with consequent heat transfer to the inside. It has been proposed to reduce these problems by wrapping the textile tube with a metallic foil for example of aluminium or with a metallised polymer film. However, if such products which are relatively inelastic are bonded directly to the surface of the tube, the result is normally a substantial loss of flexibility. It is a requirement that the end product shall bend and more-importantly stretch and/or contract and for this reason, the yarns must remain reasonably free to move relative to each other. Bonding an essentially flat reflective foil onto the yarn severely inhibits movement and the product tube is very stiff.

It is an object of the present invention to provide a highly reflective textile tube which retains good flexibility.

According to this present invention, a tubular textile product is helically wrapped with an elongated strip of a reflective foil material, characterised in that the foil strip is pre-treated so that the central region of the strip has a greater length in the axial direction than either of its side edges.



The pre-treatment step may comprise subjecting the central region to a stretching treatment, for example by pulling the strip over a forming tool such as the rim of a wheel. Alternatively, the whole strip may be stretched in the axial direction, followed by causing the longitudinal edge portions to shrink, for example by applying a heat treatment to them. Another method is to fold, pleat, gather or otherwise crimp the edge portions to reduce their length relative to that of the centre. Yet another method is to attach to each longitudinal edge a stretched elastomer or wire strip material which causes shrinkage of the edges when the elastomer or strip is allowed to relax.

When a foil strip treated as just described is helically wrapped onto a textile tube substrate with the edge portions of the strip bonded to the substrate or to overlapping edge portions of a previous winding, the product is a tube having improved flexibility despite being totally enclosed by a highly reflective foil. It will be appreciated that the flexibility arises directly from the fact that the technique described creates an excess of foil in between the substrate-contacting portions of the overlaid material. This excess foil not only permits considerable freedom to bend without opening up gaps between successive turns of foil, but it also permits some stretching and/or compression.

It is not necessary to actually bond every single turn directly to the substrate; bonding can take place at intervals.

In order that the invention be better understood, preferred embodiments of it will now be described with reference to the accompanying figures in which:-

Figures 1A and 1B illustrate the structure of a typical braid, showing its behaviour in various circumstances.

Figure 2 shows a foil strip pre-treated according to this invention for wrapping onto a tubular textile substrate.

Figure 3 illustrates the behaviour of the strip of Figure 2 when released after pre-treatment.

Figure 4 shows the strip of Figures 2 and 3 wrapped onto a typical tube.

Figure 5 shows the behaviour of the tube of Figure 4 when subjected to bending.

Figure 6 shows another embodiment of the invention.

Figure 7 illustrates a method of producing the strip of Figure 2.

Figure 8 illustrates a further embodiment of the invention.

Figure 9 illustrates another embodiment of the invention.

Figure 10 shows a prior art product.

Referring firstly to Figures 1A and 1B, the basic structure of a textile tube 1 made by braiding a plurality of textile yarns 2 is shown. The left hand part of Figure 1A shows the effect of subjecting the tube to axial compression, thereby causing the angle between individual yarns at their crossing points is less than  $90^{\circ}$ . The right hand portion of Figure 1A shows the effect of axial stretching, causing the angle between yarns at their crossing points being more than  $90^{\circ}$ . Figure 1B on the other hand illustrates the effect of bending a braided tube. It will be appreciated that the gaps between adjacent yarns have been shown on an exaggerated scale, for the purposes of illustration. Normally the gaps between yarns will be much smaller. However the overall effect remains exactly the same. It will also be appreciated that bonding a relatively inflexible foil layer to the surface of a material such as is shown in Figures 1A and 1B will inevitably have the effect of greatly reducing flexibility. In particular, stretching

and bending will be impracticable unless accompanied by a high risk of rupture of the covering film.

Referring now to Figures 2 and 3, Figure 2 shows a strip of metallized polyester foil that has been subjected to a stretching treatment such that the central portion 4 is stretched relative to the side edge portions 3. The effect of applying such a stretching treatment is more clearly shown in Figure 3, because the differentially stretched foil strip tends to assume a helical configuration. The slightly greater length of the central portion of the strip forms the outside diameter of the helix, whereas the inner edge portions form the inner or smaller diameter of the helix.

Figure 4 illustrates the application of the foil strip of Figures 2 and 3. In Figure 4, a braided tube 5 (shown in cross-section) has been helically wrapped with the foil strip of Figures 2 and 3. Adjacent turns overlap and are bonded to themselves and to the substrate at 7. Because the central portion of the foil has a greater length in the axial direction of the strip, it is spaced away from the surface of the tube 5 and defines between it and the surface of the tube a series of pockets or air spaces 8.

Figure 5 illustrates the effect of bending the tube of Figure 4. At the outside of the bend, the central

portions of the strip are closer to the tube surface 5, by virtue of a reduction in the height of the pockets 8A. On the other hand at the inside of the bend, the height of the pockets 8B is increased. In the one case, it is a result of an increase in the distance between individual bonding points 7 and in the other case it is a consequence of a decrease in the distance between the bonding points 7. It will be seen that a tube covered with the foil pretreated according to this present invention has significantly higher flexibility, without risk of rupturing the reflective foil covering. Similarly, the tube can be axially compressed or indeed stretched somewhat, also without risk of rupturing the foil.

Figure 6 shows a different embodiment in the invention, in which the foil strip has been stretched in three zones across its width, 9, 10, 11. When helically wrapped onto a tube 5 and bonded to adjacent turns and to the tube at the overlapped edge portions 7, the result is a bellows-like structure exhibiting excellent flexibility.

Figure 7 illustrates one method of making the foil of Figure 2. In this figure, a rotating shaft 15 carries a forming tool 16. Flat unstretched reflective film 17 is pulled around the tool 16 and the shaft 15 with the result that the centre portion 18 is stretched relative to the side edges 19.

Figure 8 illustrates how the same effect may be generated by pleating the edges of the film. In the figure the central portion 20 of the film is unpleated. The edge regions 21 and 22 are pleated by generating a succession of individual folds or pleats 23. It will be appreciated that this has the same effect as the treatment illustrated in Figure 7.

Figure 9 illustrates a different approach, in which the film 25 is attached along both side edges to strips of elastomeric material 26, 27 respectively. As shown towards the right hand side of the figure, the film is attached to the strips whilst the latter are stretched. The attachment may be continuous or discontinuous, for example by means of a continuous or discontinuous stripe of adhesive. The overall effect is much the same, because as shown in the left hand part of Figure 9, on allowing the elastic strips to contract to their normal length the edge portions of the film are gathered, forming a series of folds 30.

By contrast, figure 10 shows a prior art approach to the problem. This figure shows a helical wire reinforcement 35, onto which is wrapped one or more strips 36 of a reflective tape which may be a metallised plastics foil or paper. For the purposes of illustration, the pitch of the helix has been shown on a somewhat exaggerated scale.

Wrapping is carried out with the wire helix slightly extended in the axial direction so that after wrapping and bonding the reflective strip material around its exterior, the helix can be allowed to relax thereby creating a concertina-like folding of the wrapping material. The resultant product has excellent flexibility combined with axial compressibility, but unlike a braid or knitted tube, it is unable to expand radially, for example to fit over a component of larger diameter.

The invention will now be further described with reference to the following examples.

#### Example 1

A 12um thick and 13mm wide strip of vacuum aluminised polyester film was drawn under tension across an aluminium tool to the design shown in Figure 7. This was held at a temperature of 150°C and induced stretching of the central part of the film such that it naturally formed a helix with an internal diameter of about 15mm. The stretched strip was then wrapped around and bonded to a glass fibre braided tube of about 15mm diameter. Adjacent turns overlapped by about 2mm. The resulting wrapped tube maintained almost all of its ability to bend, but exhibited excellent heat-reflecting properties.

### Example 2

The unstretched polyester film strip of example 1 was adhesively bonded at its edges to two silicone elastomer bands, 1mm thick and 3mm wide. Prior to bonding these were stretched to 1.5 times their relaxed length (as shown at the right hand side of Figure 9). After bonding to the strip the bands were allowed to relax to their original length, (as shown in the left hand portion of Figure 9). When the bands relaxed, the product tended to take up the shape of a helix of about 15mm in diameter. The strip was wrapped around and bandaged to a glass fibre braided tube of about 15mm in diameter. Once again the treated tube was able to both bend and stretch/contract (with corresponding changes in diameter) without significant difficulty. It exhibited excellent heat reflectivity properties.

### Example 3

Example 2 was repeated using 15um thick aluminium foil in place of aluminised polyester film. This gave the product similar reflective properties but slightly lower flexibility. However it had substantially increased resistance to higher temperatures.



Example 4

Example 2 was again repeated but this time using a knitted glass fibre tube instead of a braided tube. Broadly similar results were obtained in that the product had a minimal loss of flexibility; it exhibited good heat reflective properties.

CLAIMS

1. A tubular textile artefact helically wrapped with an elongated strip of reflective foil, characterised in that the foil strip is pre-treated so that the central region of the strip has a greater length in the axial direction than either of its side edges.
2. A textile artefact according to claim 1 characterised in that the pre-treatment step comprises subjecting the central region of the foil strip to a stretching treatment.
3. A textile artefact according to claim 2 characterised in that the stretching treatment comprises pulling the strip around a forming tool so as to cause stretching of the central region of the strip.
4. A textile artefact according to claim 1 characterised in that the pre-treatment step comprises causing the longitudinal edge portions of the strip to shrink relative to the central portion.
5. A textile artefact according to claim 1 characterised in that the pre-treatment step comprises folding, pleating, gathering or crimping the edge portions of

the strip to reduce their length relative to that of the central portion.

6. A textile artefact according to claim 1 characterised in that the pre-treatment step comprises attaching to each longitudinal edge of the foil strip a pre-stretched elastomeric or spring material which causes shrinkage of said edges relative to the central portion of the strip on allowing the elastomer to relax.
7. A textile artefact according to any preceeding claim characterised in that the substrate to which the strip is applied is a braided tube.
8. A textile artefact according to any of claims 1 to 7 characterised in that the substrate is a knitted tube.
9. A textile artefact according to any preceeding claim characterised in that the reflective foil strip is a metal foil, the metal being selected from aluminium or nickel.
10. A textile artefact according to any of claims 1 to 7 characterised in that the reflective foil is a metallised polymer film.

Patents Act 1977  
Examiner's report to the Comptroller under  
Section 17 (The Search Report)

Application number

9023052.5

Relevant Technical fields

(i) UK Cl (Edition K ) F2P (PP1, PP9, PF1, PC29, PC27,  
PC12); F2G (G37)

(ii) Int Cl (Edition 5 ) F16L 59/08, 59/10

Search Examiner

B J PROCTOR

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

15.1.91

Documents considered relevant following a search in respect of claims

1 at least

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1307942 (HANRAHAN) eg page 4 lines 23-57	Claims 1 2,4,6,8, 10 at least
X	GB 985241 (H.D.K.W.) eg page 2 lines 31-38	Claims 1 5 at least
X	GB 942370 (UNION CARBIDE) eg figures 4,7	Claims 1 at least

SF2(p)

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